Planetary Nebulae in our Galaxy and Beyond
Proceedings IAU Symposium No. 234, 2006
M. J. Barlow & R. H. Méndez, eds.

DOI: 00.0000/X000000000000000X

Missing Galactic PNe: [S III] Imaging Survey

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Abstract. The total number of Galactic planetary nebulae (GPNe) is highly uncertain; the most inclusive current catalog contains only $\sim$ 1,500. We will use the PRISM wide-field imager on the 1.83 m Perkins Telescope to conduct a pilot survey of the Galactic plane in search of [S III] emission from PNe obscured by dust and missed by surveys of H α. We are employing the method of Jacoby & Van de Steene (JVS), who surveyed the bulge for [S III] λ9532. In addition to seeing through more of the extinction, use of the [S III] emission line will *a priori* reject the most troublesome catalog contaminants: ultracompact H II regions.

Keywords. Surveys, Catalogs, Galaxy: disk

Current estimates of the number of Galactic Planetary Nebulae (GPNe) in the Milky Way range from a few thousand (de Marco & Moe 2005) to several tens of thousands (Frew 2006). The actual number of observed and verified GPNe is just $\sim$ 3,000 (Parker *et al.* 2003). Figure 1 is an updated version of the histogram compiled by Kistiakowsky & Helfand (1993), showing the Galactic latitude distribution of GPNe in the Catalogue of Galactic Planetary Nebulae (Kohoutek 2001). The sample includes all GPNe at low Galactic latitude, and $|\ell| > 10\,^\circ$ (to exclude the Galactic bulge). There is a clear deficit in the number of known GPNe near $b = 0\,^\circ$, most likely due to obscuration by dark clouds. This low-latitude region is not easy to survey for GPNe using the standard [O III] or Hα signposts because of the large extinctions.

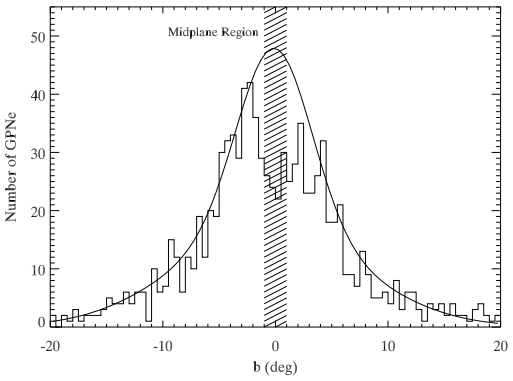

Figure 1. Numbers of known disk PNe binned by Galactic latitude.

The [S III] λ9532 emission line is seen in most PNe. Ultra-compact H II regions (UCH II regions) are the most numerous contaminants of current GPNe catalogs. Detectable [S III] λ9532 emission is expected from only the hottest and most massive UCH II regions due to the high ionization levels needed to produce and sustain S^{++}. The [S III] λ9532 line has been used at least twice before to look for PNe. Kistiakowsky & Helfand (1993) looked for [S III] λ9532 emission from compact 20 cm radio sources in the Galactic plane, finding [S III] emission toward 10 of 11 candidate PNe, but none associated with candidate SNRs. JVS surveyed the center $4\,^\circ \times 4\,^\circ$ of the Milky Way for extincted PNe, finding 94 new

candidates—roughly 6 per square degree. Each group found [S III] λ9532 to be the most prominent line for V-band extinctions of 4 to 12 mag.

Our survey uses two 20 Å narrow bandpass interference filters to sample the emission line and spectrally adjacent continuum. The on-band filter rejects the Paschen 8 recombination line at 9546 Å, while avoiding telluric OH lines. The off-band filter is close in wavelength while also avoiding telluric OH. Two matched filters, placed close together, produce differenced images able to accurately identify [S III] emission sources, and thus candidate GPNe (see Fig. 2)

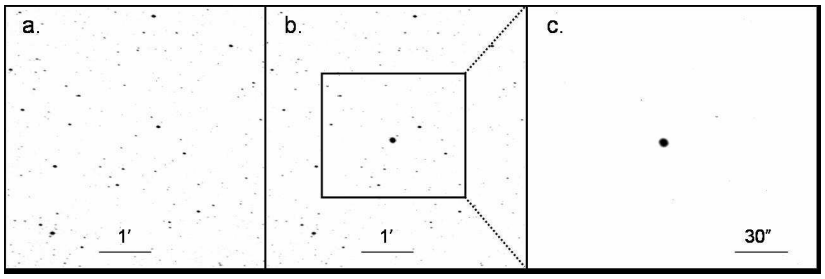

Figure 2. Test field in the Galactic plane, centered on PNG326.7+00.7. **a.)** off-band image **b.)** on-band image **c.)** an enlarged portion of the on-minus-off differenced image.

Observations will be conducted during Summer (and possibly Fall) 2006 using the new *Perkins Re-Imaging System (PRISM)* on the Perkins 1.83 m telescope in Flagstaff, AZ. Figures 2a and 2b display PRISM's $10' \times 10'$ effective field-of-view. Five minute integrations through each filter for each field allow us to reach the same depth as the JVS survey. We will observe the Galactic plane in one-field-wide latitude strips from $b = -1\,^\circ$ to $b = +1\,^\circ$. Some known GPNe and H II regions will be sampled for calibration.

The images obtained through each filter will be calibrated and on-minus-off differenced images will be computed. We will visually inspect the differenced images in search of resolved [S III] emission, compile point source catalogs with pairs of filter magnitudes, and perform magnitude differencing in search of unresolved [S III] λ9532 emission. The resulting list of candidate GPNe will be cross-referenced with current Hα and centimeter-wavelength radio surveys for confirmatory evidence about the candidate sources. We expect that verified GPNe selected as candidates using the [S III] λ9532 emission line will form a deep, minimally contaminated list of Galactic Planetary Nebulae.

We thank George Jacoby for his help and advice. JS is supported by the NSF-REU Program under grant AST–0440936–1. PRISM was developed with support from the NSF (AST–0079541, KAJ, P. I.), Boston Univ. and Lowell Obs.

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